HEAT INDEX CLIMATOLOGY FOR THE NORTH-CENTRAL UNITED STATES

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1. Introduction

Heat is an underrated danger, with an average of 175 Americans losing their lives annually from heat-related causes. According to the Centers for Disease Control and Prevention, from 1979-2003 excessive heat exposure caused 8,015 deaths in the United States. During this period, more people died from extreme heat than from hurricanes, lightning, tornadoes, and floods combined.

Heat kills by taxing the human body beyond its ability to cool itself. Cooling is primarily accomplished by the evaporation of perspiration. How efficiently this process functions is directly related to the amount of water vapor in the air. High moisture content reduces the evaporative cooling rate of perspiration, making it difficult for the body to maintain a steady and safe internal temperature. One way to measure the combined effect of temperature and moisture on the human body is the heat index.

In 1979, R. G. Steadman constructed an apparent temperature table using temperature, relative humidity, and other factors, based on a number of published research papers over a 54-year span. The National Weather Service (NWS) developed a heat index equation based on Steadman's work as guidance for heat-related advisories or warnings. Heat advisories or warnings are issued to the public when values approach dangerous levels.

This study will attempt to show the frequency of various heat index values for a section of the United States, focusing on the Plains, upper and middle Mississippi River Valleys, and the western Great Lakes. Also, the physiological response to heat will be briefly investigated, including a review of how heat acclimatization affects the human body's biology. This protective biological response is an important consideration when evaluating the impact of the heat on those that are, or are not, acclimatized to the heat.

In this study, 95°F will be used as the start for the climatological analysis as prolonged exposure to heat this warm increases the risk of sunstroke, heat cramps, and heat exhaustion (Table 1) .

2. Data

All available weather observations from the National Climatic Data Center were used from 192 locations (Fig. 1), extending from Utah to Michigan, and from the Canadian-U.S. border south to a northern New Mexico to Arkansas line. Initially, the period of record used was the last set of climate normals, 1971-2000. Due to some data unreliability and station closures, a majority of the sites only had data extending back to 1973. This study focused on the summer months of June, July and August, when the combination of heat and humidity produces the highest heat indices. Some areas of study were under-represented by the original data set. In an attempt to fill these data voids, "newer" locations were used and therefore more recent data (1990 to the present) were incorporated into the data set. These additional data were used sparingly, trying to keep the data set as true to the 1971-2000 period as possible.

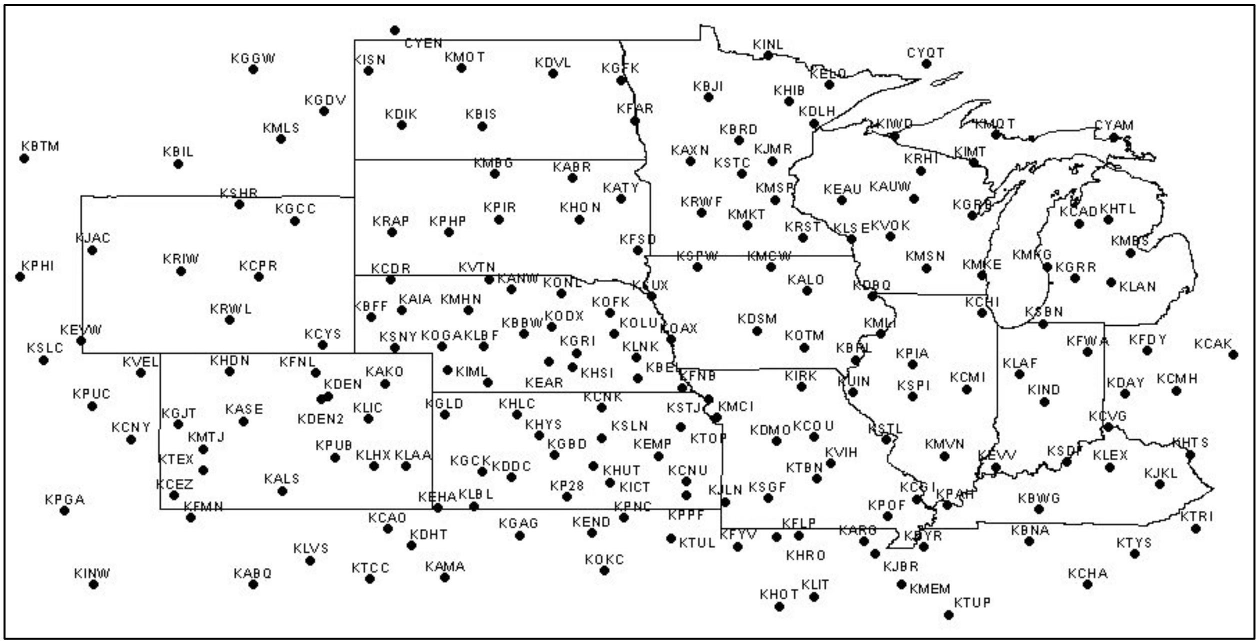

Fig 1. Observation sites used in this study.

The data were quality controlled and observations were eliminated where the temperatures and dew points were suspect or missing. If there was any question to the integrity of an observation, it was eliminated from the data set.

Appendix A contains a full listing of the sites used and related data.

3. Results

The frequency of occurrence of heat indices from 95°F to 110°F (every 5 degrees) was calculated over the data domain, along with air temperatures of 95 degrees or greater (Figs. 2-6). A 110°F heat index was used as the extreme value for analysis as data indicated that heat indices warmer than 110°F occurred very infrequently (generally less than 5 observations out of 10,000). Even in the warmest, most humid areas, percentages of observations with heat indices over 110°F were predominantly under 0.5%.

Examining the frequency of occurrence of 95°F degree or greater air temperatures (Fig. 2), a broad maximum is located across much of the Central Plains into portions of southern South Dakota. This was expected as the latitude and geographical and climatic location (humid continental to semi arid; Fig. 7) favor warm to hot summer temperatures. The maximum over the Badlands of South Dakota is also a favored location for warm to hot summer temperatures due to terrain and relative lack of vegetation (Fig. 8).

Within this broad maximum are a few areas where the percentage of warm air temperatures is reduced. Across southern Missouri, the somewhat higher elevation and more densely vegetated Ozarks keep this region cooler than locations to its south and west. The higher elevation of the Black Hills in western South Dakota keep that area relatively cooler compared to the warmer Badlands to the south and east. South of the Badlands are the Sand Hills of Nebraska, which is another minimum. The Sand Hills is a region of mixed-grass prairie covering just over one-quarter of Nebraska, and is the largest and most intricate wetland ecosystem in the United States. It's this ecosystem that keeps it cooler than surrounding territories.

Inspecting the heat index maps (Figs. 3-6), a maximum is noted from the Central Plains east to the middle Mississippi River Valley. The

Central Plains are a favored location for warm to hot summer temperatures and high heat indices are expected. Meanwhile, the middle Mississippi River Valley is generally not as warm as locations to the west, but dew points during the summer are high. This is largely the result of two processes: moisture from the Gulf of Mexico transported north, and evapotranspiration from vegetative cover. Looking more closely at this broad area, the influence of the Ozarks is noted with a relative minimum of high heat indices in this area (Figs. 4-5).

A few other, more minor maxima are evident, especially on the 100°F or greater heat index map (Fig. 4). Over central South Dakota, a maximum is indicated near Pierre and areas to the east. While there are not many data points in this area, this maximum appears to be valid for a couple reasons: geography and irrigation. In South Dakota the terrain transitions from a hilly, drier, and more arid land in the west (Black Hills and the Badlands), to flatter terrain, more vegetation and crops in the east. The higher percentage of crops and vegetation requires more irrigation resulting in additional evaporation and evapotranspiration.

Another minor maximum is located over southwest Minnesota. This area is located on the lee side of the Buffalo Ridge, which is a large expanse of rolling hills and the second highest point in Minnesota. Down sloping winds off this ridge can lead to warmer temperatures compared to surrounding portions of Minnesota. In addition, agriculture is predominant across southern Minnesota, adding moisture via evapotranspiration. These influences likely play a role in the higher heat indices.

A minimum in the heat index is indicated over southeast Minnesota (Figs. 3-4). Rochester is the data point associated with these lower values, and this observation site is located at the airport, on an open and unsheltered ridge south of the city. Its location makes it cooler than surrounding areas, with lower dew points. Therefore, while representative for the data point itself, the localized minimum is not as widespread as the figures would suggest.

One more maximum of note is located over southeast Colorado, and is only apparent on the 95°F air temperature and heat index maps (Figs. 2-3). A likely explanation for this would be deep mixing in the afternoon leading to warm temperatures but low humidities. Further investigation of the data points responsible for this maximum (PUB, LAA, and LHX) revealed that all the instances of 95-degree temperatures or heat indices occurred late in the afternoon, during peak heating. Relative humidities were less than 30% in nearly all cases with temperatures above 100°F about 60% of the time. This supports the maximum indicated in Figures 2 and 3. However, at temperatures this warm, further moisture would be required to raise the heat indices higher. In a deeply mixed environment, this is difficult to accomplish without some form of moisture advection. Since this is rare on days this warm over southeast Colorado, a maximum is not evident for heat indices above 95°F (Figs. 4-6).

In the more northern latitudes, temperatures are generally not as warm, nor is there a nearby large source of moisture (i.e., Gulf of Mexico). Therefore, the frequency of high heat indices is much less.

4. Physiological Effects of Heat

The body tries to maintain a consistent temperature by using various means to cool or warm itself. When blood is heated above 98.6°F, the body attempts to dissipate this extra heat by losing water through the skin and sweat glands, varying the rate and depth of blood circulation, and as a last resort – panting. About 90 percent of the body’s heat is lost through the skin, mostly through perspiration. Above 98.6°F, heat can only be lost through sweating.

Sweating itself does not cool the body; rather, it's the evaporation of this water that performs this function. Energy is required to change liquid water into a vapor, and the body provides this in the form of heat. However, some water vapor condenses back onto the body, returning some of that heat energy back to the body. In order for the body to cool, the rate of evaporation needs to exceed the rate of condensation. As the humidity increases, the rate of condensation starts to limit the amount of cooling from evaporation, causing the core body temperature to rise. In addition to overheating, the loss of water through sweating can lead to dehydration and can cause chemical imbalances in the body as essential minerals (such as salt) are lost through the sweat. Dehydration also depletes the body of water needed for sweating and thickens the blood. The heart has to pump harder to move the blood through the body, straining the heart and blood vessels as it does. The increased heart rate and blood flow can cause harm, or even death, to those with heart or circulatory diseases.

Heat Index	Possible heat disorders for people in higher risk groups
130°F or higher	Heatstroke/sunstroke highly likely with continued exposure.
105-130°F	Sunstroke, heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.
90-105°F	Sunstroke, heat cramps and heat exhaustion possible with prolonged exposure and/or physical activity.
80-90°F	Fatigue possible with prolonged exposure and/or physical activity.

Table 1. Heat indices and the heat-related disorders possible within each range (source: http://www.weather.gov/om/brochures/heatwave.pdf).

Overall, the inability of the body to shed heat, and the loss of fluids and minerals through sweating, can result in various heat-related disorders and illnesses, such as heat cramps, heat exhaustion, and heat stroke (Table 1). One common element to them all is that the individual affected has either overexposed or overexerted him or herself in a very warm (and likely humid) environment. Research has also shown that the severity of heat disorders increases with age. For instance, what may cause heat cramps in a 17-year old could result in heat exhaustion in someone 40, while a 60-year old could suffer heat stroke.

Heat Acclimatization

Heat acclimatization is a term used to describe the physiological adaptations associated with prolonged exposure to high environmental temperatures. During the process, resting pulse rate decreases, blood flow to the skin improves, and sweating increases. Sweat becomes more watery so that heat loss from the body can be maximized without losing too much salt. Heat-acclimatized individuals suffer less from nausea, dizziness, and discomfort in hot conditions.

The bulk of the available research focuses on short-term acclimatization: how quickly individuals laboring or performing strenuous athletics in high heat environments can adjust to the heat. Acclimatization takes about 1 to 2 weeks, but when removed from this environment, can be lost in nearly the same amount of the time. Resting in the heat results in some acclimatization, but a greater adaptive state can be induced by intermittent exposure to exercise in the heat (Greenleaf and Kaciuba-Uschiko 1989). A degree of acclimatization can also be achieved by just living and working in a hot climate. However, those that participate in strenuous outdoor activities usually acclimatize more rapidly, and retain the benefits longer, compared to sedentary individuals.

This research supports the perception that individuals that are more accustomed to the heat (i.e., live in a warmer climate) will have a higher tolerance and be less affected by it, compared to individuals that live in cooler climates. However, the research also suggests that full acclimatization occurs by coupling active outdoor activities (sports, labor, etc.) with a very warm environment.

Heat acclimatization acts to protect the body from the heat. When discussing the impacts of high temperatures and humidity, this biological response should be taken into consideration.

5. Summary

Heat is an underrated danger, and the heat index is a way to assess the threat from the combined effects of the air temperature and humidity. Around 175 people in the United States lose their lives each year from heat related causes.

A review of historical summer (June through August) observations for 192 locations, mostly across the Plains and upper and mid-Mississippi River Valleys showed a propensity for dangerous heat across the Central Plains into the mid-Mississippi River Valley. The geographic and climatic location, along with proximity to the Gulf of Mexico, makes these areas prone to very warm temperatures, and in some cases, high humidity. This results in more frequent and higher heat indices. Other more localized maxima are located over portions of central South Dakota, and southwest Minnesota. Across the bulk of the Northern Plains and Great Lakes States, frequencies of high heat indices are much lower due to the latitude and geographical location.

Research has shown that active individuals in warm environments can become acclimatized to the heat. The body adjusts to these high heat conditions, helping to protect itself from the heat's effects. Comparatively, sedentary individuals in a similar environment do not acclimatize as well and will be at a higher risk to suffer from heat-related illnesses. Individuals unaccustomed to very warm environments, such as those that live in higher latitudes, will also be at a greater risk as their bodies have had little exposure, and therefore time, to acclimatize.

6. References

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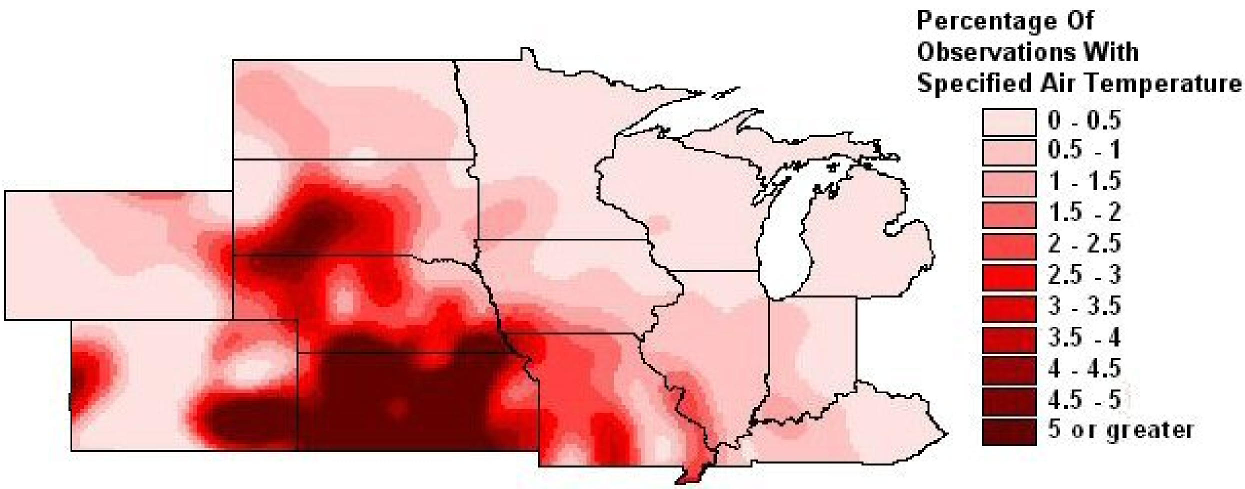

Fig 2. Percent of observations with an **air temperature of 95°F or greater** June through August.

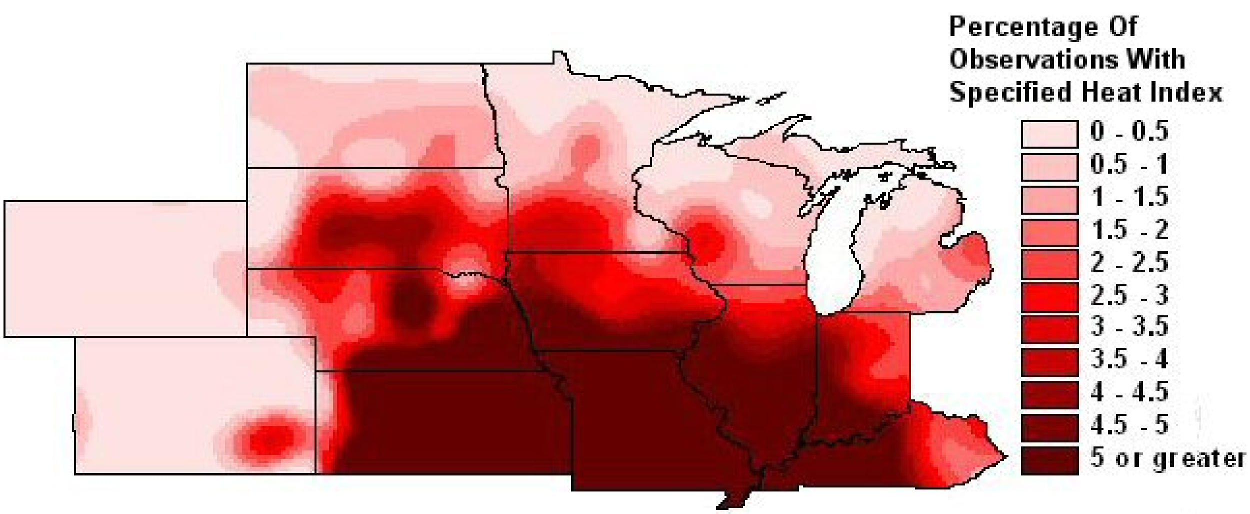

Fig 3. Percent of observations with **heat indices of 95°F or greater** June through August.

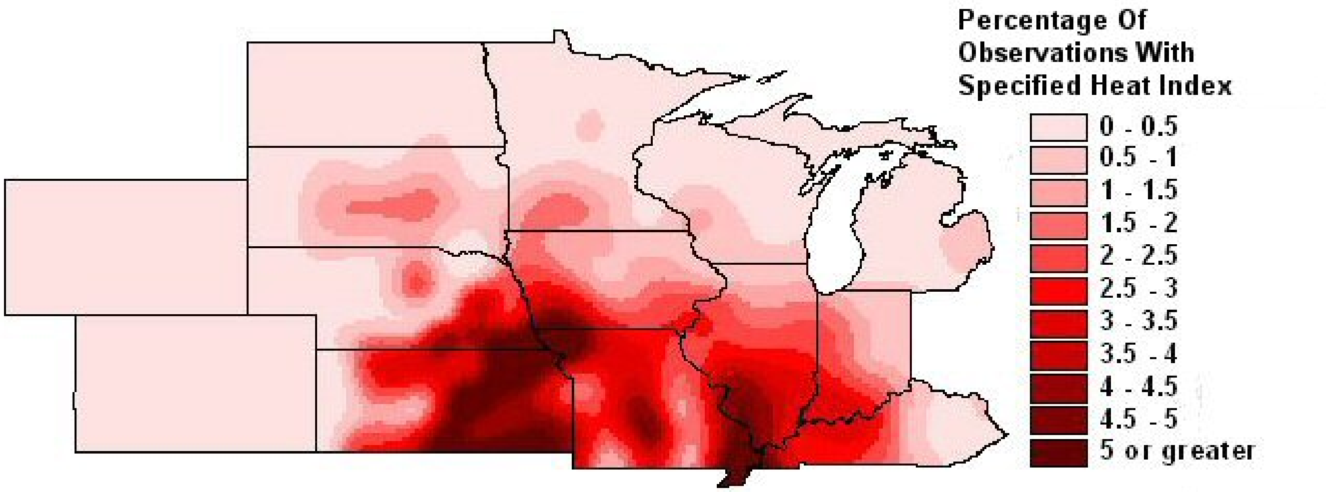

Fig 4. Percent of observations with **heat indices of 100°F or greater** June through August.

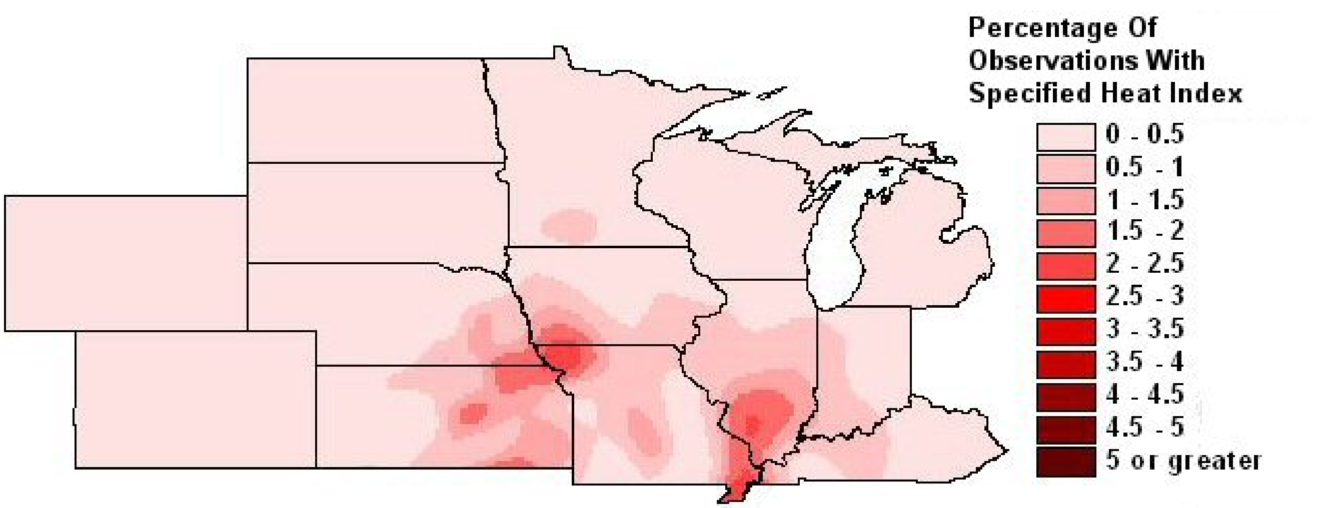

Fig 5. Percent of observations with **heat indices of 105°F or greater** June through August.

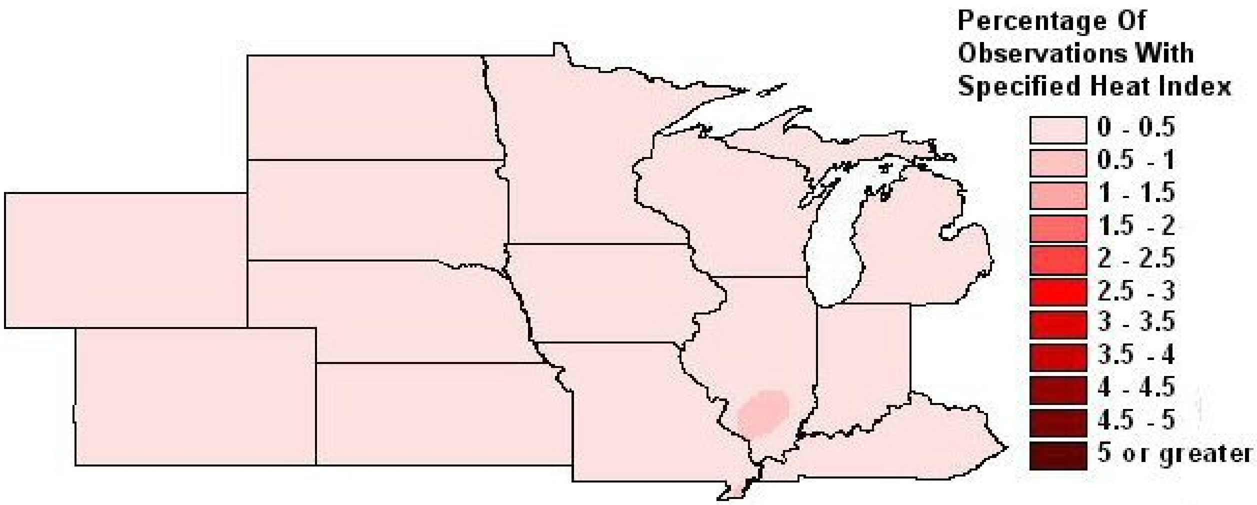

Fig 6. Percent of observations with **heat indices of 110°F or greater** June through August.

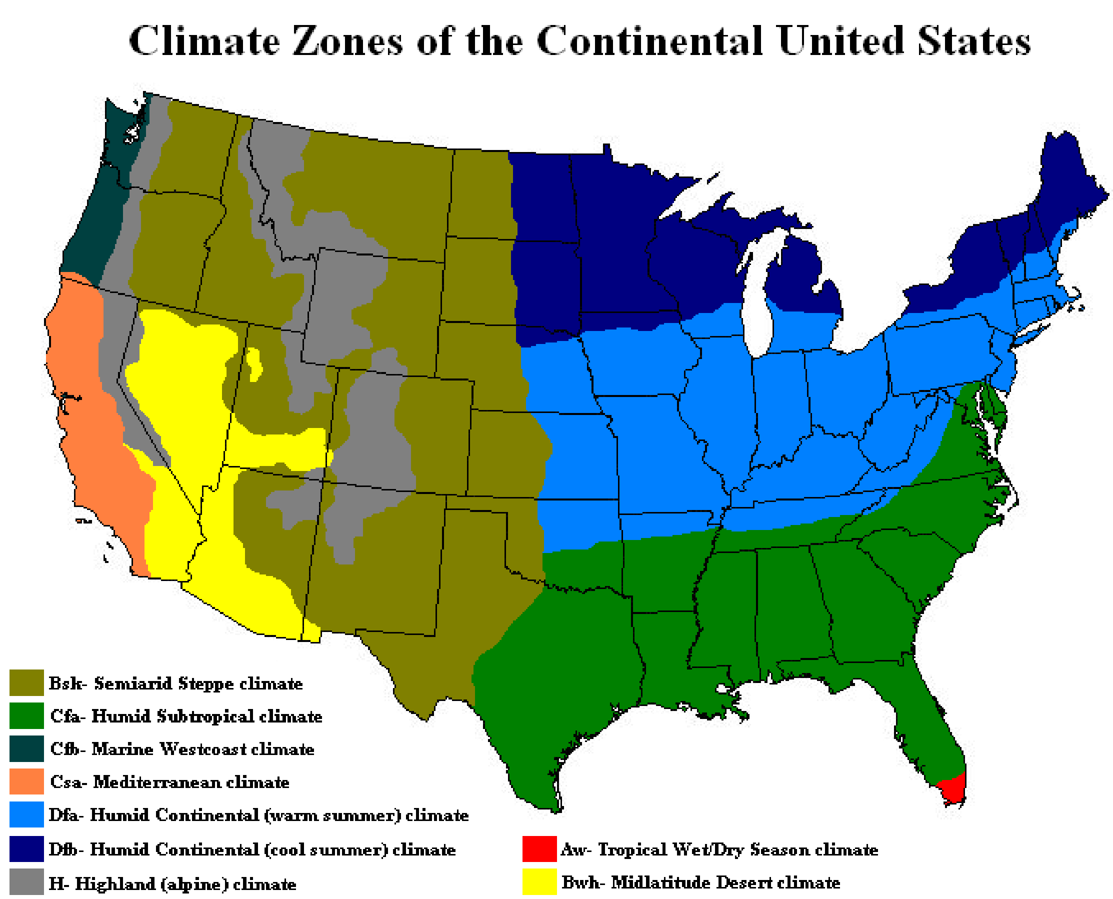

Fig 7. Climate zones of the Continental United States (source: http://en.wikipedia.org/wiki/File:Climatemapusa2.PNG).

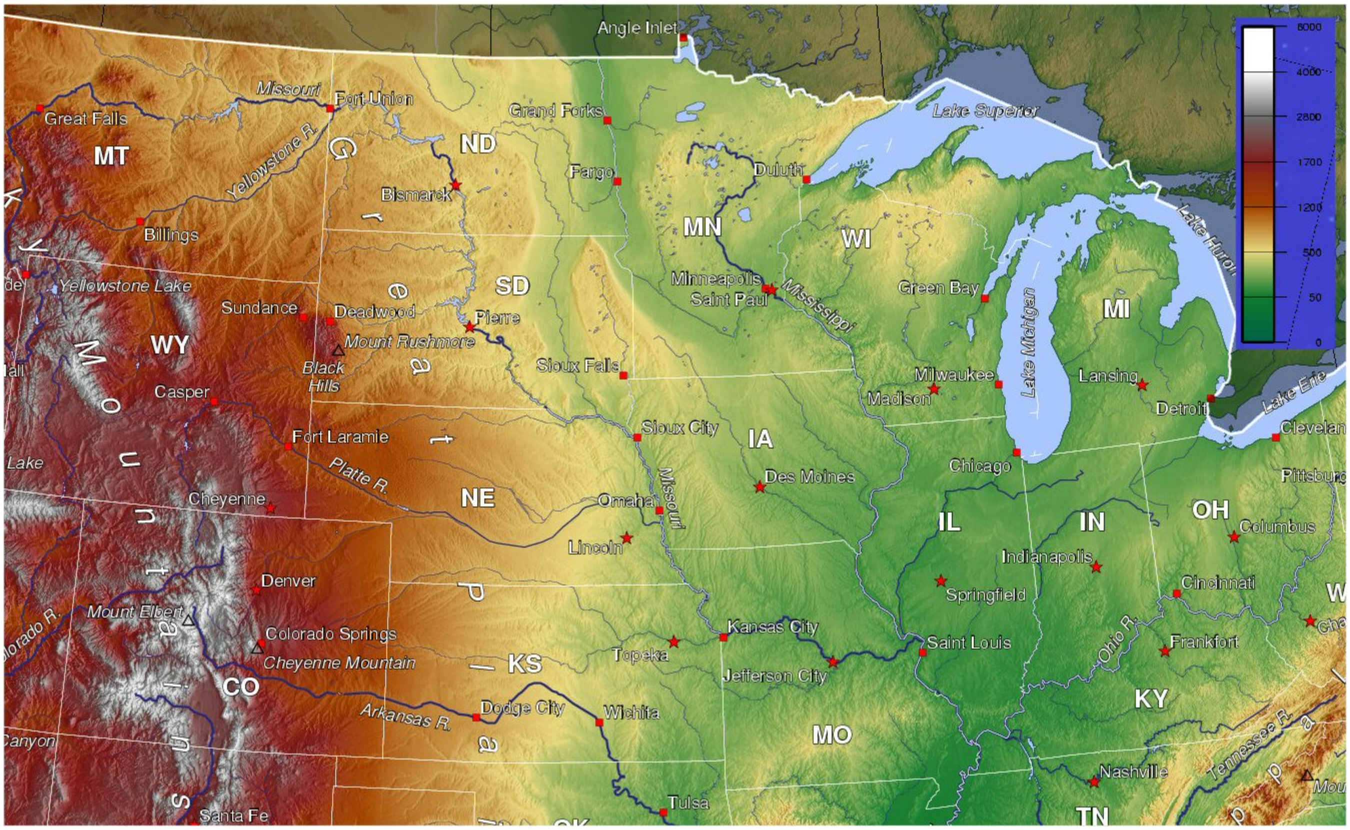

Fig 8. Topography map from the Rocky Mountains east to the Great Lakes and Ohio River Valley (source: http://commons.wikimedia.org/wiki/File:USA_topo_en.jpg)

APPENDIX A

Observation sites included in this study, with total number of observations (OBS total), number of observations with an air temperature of 95°F or greater (95°F or greater), percentage with 95°F or greater air temperature (%95°F or greater), and percentage of certain heat indices (for example, HI 100°F % represents the percentage of observations that produced a 100°F or warmer heat index in the data set).

Site ID	Name	OBS total	95°F or greater	% 95°F or greater	HI 95°F %	HI 100°F %	HI 105°F %	HI 110°F %
KABR	Aberdeen	58201	749	1.3	2.53	0.95	0.22	0.03
KANW	Ainsworth	35636	1065	3	3.9	0.85	0.13	0.01
KAKO	Akron, CO	55352	723	1.3	0.17	0	0	0
KCAK	Akron, OH	64902	56	0.1	0.83	0.16	0.04	0
KALS	Alamosa	49492	0	0	0	0	0	0
KABQ	Albuquerque	63082	1759	2.8	0.36	0	0	0
KAXN	Alexandria	59679	156	0.3	1.17	0.3	0.06	0.01
KAIA	Alliance	36234	1203	3.3	1.54	0.2	0.02	0
KAMA	Amarillo	65307	2264	3.5	1.63	0.09	0	0
KASE	Aspen	38208	0	0	0	0	0	0
KBEI	Beatrice	32570	2037	6.3	12.7	5.78	1.66	0.37
KBJI	Bemidji	46788	89	0.2	0.51	0.1	0.01	0
KBIL	Billings	63052	798	1.3	0.26	0.01	0	0
KBIS	Bismarck	63882	656	1	1.16	0.35	0.03	0
KBWG	Bowling Green	59950	673	1.1	7.55	2.74	0.74	0.17
KBRD	Brainerd	39707	145	0.4	1.87	0.68	0.16	0.06
KTRI	Bristol	28872	27	0.1	0.83	0.07	0	0
KBBW	Broken Bow	31405	805	2.6	4.88	1.12	0.16	0.04
KBRL	Burlington	58224	562	1	5.87	2.74	0.98	0.26
KBTM	Butte	48529	21	0	0	0	0	0
KCAD	Cadillac	38215	41	0.1	0.53	0.23	0.09	0.03
KVOK	Camp Douglass	21950	106	0.5	2.63	0.94	0.31	0.1
KCGI	Cape Girardeau	59918	1236	2.1	12.22	5.75	1.98	0.49
KCPR	Casper	63086	518	0.8	0.04	0	0	0
KCDR	Chadron	42804	2048	4.8	2.19	0.23	0.01	0
KCMI	Champaign/Urbana	50016	382	0.8	5.7	2.62	1.12	0.35
KCNU	Chanute	50682	2067	4.1	12.43	5.17	1.58	0.4
KCHA	Chattanooga	64278	1016	1.6	7.71	2.34	0.5	0.13
KCYS	Cheyenne	64290	34	0.1	0	0	0	0
KCHI	Chicago	63606	317	0.5	3.05	1.2	0.38	0.11
KCAO	Clayton	65536	906	1.4	0.14	0	0	0
KCOU	Columbia	64308	1032	1.6	7.54	3.13	0.84	0.11
KCMH	Columbus	64362	172	0.3	2.43	0.68	0.1	0.02
KOLU	Columbus, NE	39490	1143	2.9	7.99	3.68	1.25	0.34
KCNK	Concordia	64294	2946	4.6	8.25	3.21	0.75	0.1
KCEZ	Cortez	22147	93	0.4	0.22	0.05	0.03	0.01
KCVG	Covington	64390	232	0.4	3.28	0.99	0.2	0.02
KDHT	Dalhart	50171	1740	3.5	1.19	0.04	0	0
KDAY	Dayton	65036	199	0.3	2.36	0.65	0.15	0.04
KDEN2	Den-Stapleton	48708	438	0.9	0.06	0	0	0

Site ID	Name	OBS total	95°F or greater	% 95°F or greater	HI 95°F %	HI 100°F %	HI 105°F %	HI 110°F %
KDEN	Denver	37913	550	1.5	0.09	0	0	0
KDSM	Des Moines	64240	731	1.1	4.2	1.7	0.61	0.09
KDVL	Devils Lake	16219	98	0.6	0.94	0.17	0.02	0.01
KDIK	Dickinson	57437	656	1.1	0.6	0.09	0.01	0
KDDC	Dodge City	65535	4539	6.9	7.11	1.79	0.17	0.01
KDBQ	Dubuque	50051	117	0.2	2.35	0.88	0.25	0.05
KDLH	Duluth	65535	7	0	0.16	0.01	0	0
KDYR	Dyersburg	44909	1096	2.4	17.57	7.76	2.57	0.72
KEAU	Eau Clairie	63116	201	0.3	1.3	0.52	0.13	0.04
KEHA	Elkhart	17816	895	5	2.11	0.26	0.06	0.01
KELO	Ely	64587	23	0	0.43	0.09	0.01	0
KEMP	Emporia	45852	1860	4.1	11.32	4.31	1.14	0.25
KEND	Enid	62241	5270	8.5	13.03	5.3	1.04	0.1
CYEN	Estevan	50953	250	0.5	0.28	0.04	0.01	0.01
KEVW	Evanston	23137	0	0	0.01	0.01	0	0
KEVV	Evansville	64707	836	1.3	8.78	3.56	1.01	0.18
KFNB	Falls City	19354	959	5	13.9	6.74	2.01	0.42
KFAR	Fargo	63958	290	0.5	1.25	0.35	0.09	0
KFMN	Farmington	53526	738	1.4	0.08	0	0	0
KFYV	Fayetteville	57912	1108	1.9	8.63	2.6	0.46	0.05
KFDY	Findlay	59878	129	0.2	1.76	0.57	0.11	0.03
KFLP	Flippin	55858	2004	3.6	9.19	3.14	0.59	0.03
KFNL	Fort Collins	20099	38	0.2	0	0	0	0
KFWA	Fort Wayne	64570	236	0.4	2.59	0.89	0.24	0.05
KTBN	Ft. Leonard Wood	38795	1213	3.1	11.58	4.39	1.27	0.33
KGAG	Gage	54600	4426	8.1	9.21	2.08	0.23	0.05
KGCK	Garden City	57813	3875	6.7	6.46	1.4	0.04	0
KGCC	Gillette	53108	643	1.2	0.22	0.01	0.01	0
KGGW	Glasgow	63233	790	1.2	0.43	0.04	0	0
KGDV	Glendive	20308	238	1.2	0.38	0.06	0	0
KGLD	Goodland	65535	1960	3	1.29	0.04	0	0
KGFK	Grand Forks	61826	191	0.3	0.95	0.22	0.04	0
KGRI	Grand Island	65318	1649	2.5	4.93	1.81	0.35	0.06
KGJT	Grand Junction	62687	2393	3.8	0.43	0.01	0	0
KGRR	Grand Rapids	64604	69	0.1	1.41	0.37	0.05	0.02
KGBD	Great Bend	18952	842	4.4	6.64	1.74	0.12	0.01
KGRB	Green Bay	65130	110	0.2	0.88	0.4	0.12	0.04
KHRO	Harrison	56342	932	1.7	6.83	1.83	0.41	0.13
KHSI	Hastings	33410	1249	3.7	8.89	3.6	0.91	0.2
KHDN	Hayden	25096	0	0	0	0	0	0
KHYS	Hays	19563	1209	6.2	6.99	2.12	0.21	0
KHIB	Hibbing	59292	23	0	0.25	0.03	0	0
KHLC	Hill City	41790	3975	9.5	10.57	3.46	0.6	0.09
KHOT	Hot Springs	42280	3470	8.2	24.42	10.88	3.31	0.49
KHTL	Houghton Lake	53056	38	0.1	0.43	0.08	0.02	0.02
KHTS	Huntington	65535	244	0.4	3.13	0.71	0.12	0.02
KHON	Huron	63492	1028	1.6	3.58	1.42	0.36	0.07

Site ID	Name	OBS total	95°F or greater	% 95°F or greater	HI 95°F %	HI 100°F %	HI 105°F %	HI 110°F %
KHUT	Hutchinson	34369	2817	8.2	13.25	5.62	1.36	0.26
KIML	Imperial	19995	586	2.9	2.45	0.5	0.1	0.02
KIND	Indianapolis	64589	222	0.3	3.18	1.44	0.4	0.05
KINL	International Falls	63445	30	0	0.25	0.04	0	0
KIMT	Iron Mountain	30953	38	0.1	0.91	0.44	0.12	0.05
KIWD	Ironwood	41533	33	0.1	0.43	0.06	0.01	0
KJAC	Jackson	38552	0	0	0	0	0	0
KJKL	Jackson, KY	56216	94	0.2	1.9	0.39	0.05	0
KJBR	Jonesboro	56049	2008	3.6	16.67	7.56	2.33	0.44
KJLN	Joplin	60881	1815	3	10.43	4.02	0.91	0.1
KMCI	Kansas City	63882	1385	2.2	8.3	2.96	0.92	0.1
KEAR	Kearney	39576	1066	2.7	5.39	1.37	0.22	0.02
KIRK	Kirksville	41107	763	1.9	7.81	3.06	0.73	0.1
KTYS	Knoxville	64711	414	0.6	4.57	1.08	0.14	0.01
KLSE	La Crosse	63263	391	0.6	2.89	1.24	0.56	0.21
KLHX	La Junta	56673	4631	8.2	3.35	0.2	0	0
KLAF	Lafayette	59684	453	0.8	4.65	1.98	0.69	0.2
KLAA	Lamar	28509	10061	7.2	2.7	0.34	0.04	0.01
KLAN	Lansing	64077	118	0.2	1.17	0.44	0.08	0.02
KLVS	Las Vegas, NM	41052	24	0.1	0	0	0	0
KLEX	Lexington	64795	228	0.4	3.24	0.77	0.08	0
KLBL	Liberal	31646	2875	9.1	9.69	2.51	0.54	0.16
KLIC	Limon	32540	100	0.3	0.01	0	0	0
KLNK	Lincoln	64774	2017	3.1	7.62	3.34	1.03	0.2
KLIT	Little Rock	25131	1499	6	21.14	11.61	4.11	0.84
KSDF	Louisville	64579	514	0.8	6.9	2.7	0.72	0.13
KMSN	Madison	64734	162	0.3	1.63	0.62	0.17	0.05
KMKT	Mankato	34118	181	0.5	3.21	1.44	0.59	0.2
KMQT	Marquette	37993	21	0.1	0.2	0.01	0	0
KMCW	Mason City	63238	272	0.4	2.8	1.14	0.31	0.05
KMCK	McCook	37625	2615	7	7.77	1.93	0.27	0.03
KP28	Medicine Lodge	48019	4791	10	13.02	5.35	1	0.07
KMEM	Memphis	63096	1948	3.1	19.1	9.13	2.84	0.61
KMLS	Miles City	37821	1494	4	1.75	0.24	0.01	0.01
KMKE	Milwaukee	64386	189	0.3	1.73	0.66	0.16	0.06
KMSP	Minneapolis	63928	283	0.4	1.92	0.67	0.18	0.03
KMOT	Minot	65536	408	0.6	0.68	0.13	0.03	0.01
KCNY	Moab	6521	360	5.5	2.5	0.18	0	0
KMBG	Mobridge	18793	185	1	1.1	0.44	0.05	0.01
KMLI	Moline	64158	561	0.9	4.84	2.19	0.78	0.21
KMTJ	Montrose	26716	210	0.8	0.09	0	0	0
KJMR	Mora	18748	6	0	0.88	0.28	0.1	0.03
KMVN	Mount Vernon	21834	193	0.9	8.48	4.04	1.89	0.68
KMHN	Mullen	20611	459	2.2	2.18	0.24	0.01	0.01
KMKG	Muskegon	63953	7	0	0.39	0.07	0.02	0.01
KBNA	Nashville	64056	926	1.4	8.12	2.54	0.48	0.04
KOFK	Norfolk	61045	1056	1.7	4.49	1.62	0.3	0.03

Site ID	Name	OBS total	95°F or greater	% 95°F or greater	HI 95°F %	HI 100°F %	HI 105°F %	HI 110°F %
KLBF	North Platte	64940	1259	1.9	2.33	0.38	0.04	0
KOGA	Ogallala	49382	1874	3.8	2.25	0.34	0.04	0
KOKC	Oklahoma City	64301	3947	6.1	13.06	4.66	0.81	0.06
KOAX	Omaha	61553	1231	2	7.05	3.41	1.18	0.24
KONL	O'Neill	17811	349	2	4.21	1.34	0.16	0.01
KODX	Ord	36987	944	2.6	5.86	1.8	0.35	0.03
KOTM	Ottumwa	58092	740	1.3	5.4	2.28	0.66	0.16
KPAH	Paducah	51099	512	1	9.54	4.11	1.07	0.13
KPGA	Page	58409	4928	8.4	1.87	0.11	0.01	0
KPPF	Parsons	25740	1106	4.3	12.06	5.52	1.47	0.14
KPIA	Peoria	64978	436	0.7	4.82	2.17	0.74	0.19
KPHP	Phillip	11978	633	5.3	4.64	1.49	0.23	0
KPIR	Pierre	65316	2538	3.9	4.43	1.62	0.42	0.07
KPHI	Pocatello	61698	665	1.1	0.13	0	0	0
KPNC	Ponca City	54476	5029	9.2	17.46	8.13	2.19	0.34
KPOF	Poplar Bluff	48409	557	1.2	11.56	5.13	1.36	0.29
KPUC	Price	32613	87	0.3	0	0	0	0
KPUB	Pueblo	62904	3199	5.1	1.19	0.02	0	0
KUIN	Quincy	59619	721	1.2	5.48	2.35	0.65	0.17
KRAP	Rapid City	63205	1151	1.8	0.95	0.13	0	0
KRWL	Rawlins	47281	26	0.1	0	0	0	0
KRWF	Redwood Falls	56641	678	1.2	3.72	1.67	0.59	0.1
KRHI	Rhinelander	34582	27	0.1	0.74	0.26	0.11	0.03
KRIW	Riverton	29691	161	0.5	0.07	0.02	0.01	0.01
KRST	Rochester	64986	106	0.2	0.92	0.43	0.12	0.02
KVIH	Rolla/Vichy	49276	796	1.6	7.22	2.31	0.56	0.19
KMBS	Saginaw	60745	159	0.3	1.54	0.54	0.15	0.05
KSLN	Salina	59651	7318	12.3	12.27	5.72	1.7	0.37
KSLC	Salt Lake City	65535	2479	3.8	0.66	0.03	0	0
CYAM	Sault Ste Marie	36401	0	0	0.06	0	0	0
KBFF	Scottsbluff	63485	1515	2.4	0.95	0.08	0	0
KDMO	Sedalia	25664	576	2.2	8.42	3.8	1.1	0.07
KSHR	Sheridan	59950	879	1.5	0.39	0.05	0	0
KSNY	Sidney	62106	1241	2	0.45	0	0	0
KSUX	Sioux City	64796	691	1.1	4.69	1.98	0.52	0.08
KFSD	Sioux Falls	64444	762	1.2	3.37	1.19	0.27	0.05
KSBN	South Bend	64697	244	0.4	2.43	0.82	0.24	0.07
KSPW	Spencer	45001	364	0.8	3.76	1.51	0.5	0.11
KSGF	Springfield	64312	1122	1.7	7.05	2.04	0.21	0.01
KSPI	Springfield, IL	64276	576	0.9	6.45	3.03	1.1	0.27
KSTC	St Cloud	46586	174	0.4	1.59	0.51	0.13	0.02
KSTJ	St Jospeh	32153	980	3	11.96	5.56	1.96	0.37
KSTL	St Louis	64454	1405	2.2	9.99	4.33	1.31	0.35
KTEX	Telluride	33574	0	0	0	0	0	0
CYQT	Thunder Bay	50802	18	0	0.11	0.03	0.01	0
KTOP	Topeka	65535	1710	2.6	9.99	4.45	1.24	0.18
KTCC	Tucumcari	39850	2895	7.3	3.05	0.27	0.01	0

Site ID	Name	OBS total	95°F or greater	% 95°F or greater	HI 95°F %	HI 100°F %	HI 105°F %	HI 110°F %
KTUL	Tulsa	65535	4472	6.8	18.07	8.79	2.85	0.6
KTUP	Tupelo	23673	771	3.3	20.13	10.05	3.78	1.51
KVTN	Valentine	65535	1753	2.7	2.55	0.64	0.06	0
KVEL	Vernal	21048	139	0.7	0.11	0.02	0	0
KARG	Walnut Ridge	19088	394	2.1	11.33	4.29	1.13	0.21
KALO	Waterloo	63667	353	0.6	3.01	1.29	0.47	0.1
KATY	Watertown	52667	359	0.7	1.7	0.47	0.08	0.01
KAUW	Wausau	41095	39	0.1	0.57	0.16	0.06	0.01
KICT	Wichita	64515	4590	7.1	11.42	4.5	0.85	0.09
KISN	Williston	63381	884	1.4	0.91	0.19	0.02	0
KINW	Winslow	65535	2393	3.7	0.39	0.01	0	0